Introduction: Arterial health may be affected by microgravity or ground based analogs of spaceflight, as shown by an increase in thoracic aorta stiffness[1]. Head-down tilt bed rest (HDTBR) is often used as a ground-based simulation of spaceflight because it induces physiological changes similar to those that occur in space[2, 3]. This abstract details an analysis of arterial stiffness (a subclinical measure of atherosclerosis), the distensibility coefficient (DC), and the pressure-strain elastic modulus (PSE) of the arterial walls during HDTBR. This project may help determine how spaceflight differentially affects arterial function in the upper vs. lower body.

Materials and Methods: Subjects were placed in a six degree HDTBR for 60 days following the standard conditions[4]. The brachial and anterior tibial arteries of 11 subjects (8M, 3F, mean age 34±9, weight 74±16kg, and height 170±9cm) and the carotid arteries of 13 different subjects (7M, 6F, mean age 35±8, weight 71±10kg, and height 168±9cm) were evaluated. Two-dimensional ultrasound images of the carotid, brachial, and tibial arteries were taken 5 days before HDTBR (BR-5), on day 60 (BR60), and 3 days after HDTBR (BR+3). Systolic (SBP), diastolic (DBP), and pulse (PP) blood pressures were also recorded within an hour of image acquisition. After averaging 3 measurements of each arteries' systolic diameter (SD), diastolic diameter (DD), and intima-media thickness (IMT), the DC $\left[\frac{2(SD-DD)}{DD*PP}\right]$, stiffness $\left[\beta = ln\left(\frac{SBP}{DBP}\right) * \frac{DD}{(SD-DD)}\right]$, and the PSE $\left[0.1333 * \frac{PP*DD}{(SD-DD)}\right]$ were calculated for each day[1, 3].

Results and Discussion: The main effect observed was that the carotid artery was significantly more distensible, less stiff, and has a smaller PSE than the tibial and brachial arteries, which were each used as the baseline in a linear mixed model analysis ($p < 0.001$). These significant differences also hold true for the tibial artery relative to the brachial artery. The data are shown in Table 1, which shows brachial mechanical values are relatively constant. The tibial artery trended towards increased DC ($p = 0.1$), less stiffness ($p = 0.06$), and smaller moduli ($p = 0.1$) from BR-5 to BR+3, indicating a remodeling effect. The tibial IMT was thinner on BR60 ($p < 0.001$) and did not recover by BR+3 ($p = 0.02$). Stiffness and the DC, or elasticity[5], follow opposite trends during HDTBR, as expected. Carotid IMT measurements were significantly thicker than the brachial and tibial IMT ($p < 0.001$). There was a significant decrease in the tibial IMT relative to the brachial response from BR -5 to BR 60 and BR+3 ($p < 0.05$). Similar to the findings of Godia et al., the values found for the arterial mechanical properties may be imprecise due to small changes in SD, DD, and IMT measurements leading to large standard deviations[6].

Table 1. Mean arterial mechanical properties ± standard deviation for pre-, during, and post-bed rest.

Day		BR-5	BR60	BR+3
DC ($*10^{-3}$ kPa^{-1})	Carotid	25.34 ±10.92	17.74 ±6.66	23.33 ±8.90
	Brachial	7.25 ±4.05	7.54 ±4.48	7.81 ±3.65
	Tibial	10.11 ±5.81	13.61 ±7.03	13.22 ±4.54
Stiffness (β)	Carotid	8.70 ±6.00	10.37 ±4.47	8.16 ±2.69
	Brachial	26.43 ±9.82	27.95 ±14.33	25.82 ±10.05
	Tibial	25.15 ±18.17	15.41 ±7.41	12.96 ±4.40
PSE (kPa)	Carotid	103 ±75	129 ±48	97 ±30
	Brachial	341 ±134	356 ±217	313 ±134
	Tibial	327 ±251	194 ±97	173 ±64

Conclusions: These data suggest that the carotid, brachial, and tibial arteries react differently to HDTBR as a ground based analog of spaceflight. After slight variations during bed rest, arterial mechanical properties and IMT return to pre-bed rest values. This does not appear to be true for the tibial stiffness and PSE, which continue to decrease post-bed rest while the DC increases. Future studies should improve methods of determining boundaries to decrease error and compare more subjects over more bed rest days.

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